INSTRUCTION MANUAL

DIGIVAC Model 215 Series

Digital Vacuum Gauges

Digivac Models

Model 215H
Model 215V
Model 215C

215H Ranges

1 to 1990 milliTorr
1.to 1990 milliBar
1 to 199.0 pascal

215V Ranges

.001 to 760 Torr
.001 to 1013 milliBar
.001 to 101.3 kilopascal

215C Ranges

.001 to 760 Torr
.001 to 1013 milliBar
.001 to 101.3 kilopascal
Subject to Capacitance Manometer Specifications

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DigiVac
Precise Practical Personal

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1.0 DESCRIPTION AND PRINCIPLE OF OPERATION.

The DIGIVAC 215 series gauges are compact digital vacuum sensing instruments. They use a thermocouple gauge tube to sense vacuum and display the reading in either milliTorr, mBar or kilopascal. The Digivac Model 215 can either be panel mounted or sit on a bench top, and comes standard with 2 SPDT controls, analog output and RS232 data. The Digivac Model 215 can use different thermocouple gauge tubes. If in doubt about what gauge sensor you have, consult the Digivac packing list that came with your instrument for positive identification.

Major models and variations are as follows:

- **Model 215H** 1/8 DIN enclosure that is shipped with either a KJL6000 or DV-6M thermocouple vacuum gauge sensor.
- **Model 215V** 1/8 DIN enclosure that is shipped with a Varian 531 Thermocouple vacuum gauge sensor
- **Model 215C** 1/8 DIN enclosure that is shipped with a capacitance manometer

Consult the Digivac website *www.digivac.com* for information about other Digivac vacuum controllers and gauges.

The Digivac **Model 215H** and **215V** operates by measuring the temperature rise of an electrically heated thermocouple exposed to a vacuum. As vacuum increases, or more correctly, as absolute pressure decreases, fewer and fewer molecules of gas are available to cool the thermocouple. With less molecules the air temperature rises and the thermocouple gauge thus senses the vacuum. A precision reference inside the Digivac in conjunction with an integrated circuit amplifier controls the electrical excitation of the sensor filament. In gauges that use KJL6000 or Hastings tubes, a precision temperature compensated AC square wave oscillator is included in the electronics. The voltage response of the thermocouple is piped through a CPU and is translated to the current vacuum reading.

The Digivac Model 215C displays the vacuum level that corresponds to an MKS Baratron Capacitance manometer output.

2.0 CONSTRUCTION

The Digivac consists of the indicating and controlling instrument, the gauge tube, the gauge tube cable, interfaces for the 2 control connections, analog out, RS232 and an AC power adapter.

The instrument is housed in a rugged free-standing plastic enclosure. It can either be placed on a suitable surface, or can be mounted in a 1/8 DIN panel cutout. The gauge tube houses the various thermocouple sensing, heating and compensating elements and terminates in an octal connector. On this model, the connector wiring terminates at the instrument with a 6 position RJ24. Regulating circuitry in the Digivac provides constant current for gauge tube excitation, and thus compensates for resistance in the probe leads.

3.0 UNPACKING AND INSPECTION

After the DIGIVAC is received, it should be carefully unpacked and inspected for damage during shipment and for completeness. The package should contain, as a minimum, the instrument, the thermocouple gage tube, the tube connecting cable, and an instruction manual. In the event of a loss during shipment, a claim should immediately be made to the common carrier or the postal service, as applicable. The Digivac warranty pertains only to the instrument, and does not cover losses in shipping.

Each 215 should come with:

- Display controller (black box with blue buttons)
- Power supply
- Gauge Tube Cable
- Varian 531 gauge tube
- Mounting Brackets
- VLC (optional)
  - A Valve with inside port (closest to body) blocked off
  - 2 feet of thin silicon tubing (to be connected between middle valve fitting and vessel)
- RS232 (optional)
  - RS232 Port
  - 6' RS232 Cable
- Ethernet (optional, includes RS232)
  - Ethernet Port
  - Null modem RS232 converter
  - 2' Ethernet Cable
  - Configuration CD

4.0 INSTALLATION

The instrument should be located in a clean, dry environment for best results. The unit can be panel mounted with the hardware provided in a 1/8" DIN panel cutout (3.64" x 1.78" [92mm x 45 mm]). Alternatively, the unit can be placed on a desktop by placing the 4 rubber feet included with your gauge on the underside of the unit. The gauge tube cable should be identified by wire tags or markings specific to your environment.

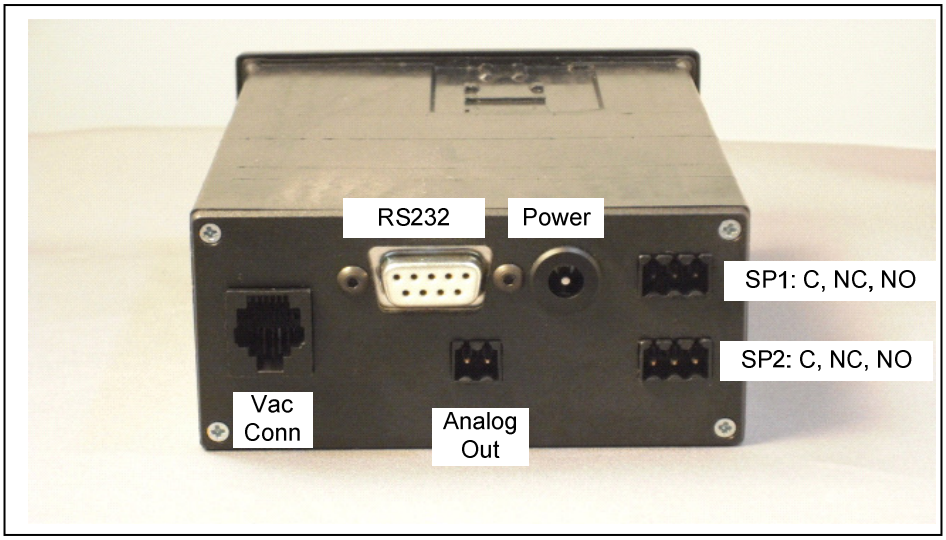
Thermocouple gauge tubes must be installed in a thread-down orientation in a clean, dry vacuum system. While threading the gauge tube in to the manifold, the gauge tube cable should be disconnected to avoid damage. In this way, twisting of the cable and the octal socket on the tube is avoided. Care should be exercised to install the tubes in a dry part of the system. Since the instrument works on the principle of temperature rise, the probes will not work if they become filled with a liquid such as vacuum or diffusion pump oil. The gauge tube should be protected against oil and other contaminants by installing it in such a way to protect it. A good practice is to mount the gauge tube in the most vertically distant place from oil and other contaminants as applicable. The gauge tube should be mounted in the most stable pressure region of the vessel to be measured. For example, it would be better to install the gauge tube on a tank rather than on the pipe that is directly connected to a vacuum pump. In the event of contamination, see section 6.0 for gauge tube cleaning instructions.

If the gauge is used in a Neon sign processing facility, the following is recommended to protect the gauge from damage from bombarding:

- The gauge tube should be isolated from the system with a stopcock. The stopcock should be closed when bombarding.
- There should be at least 2 feet of tubing between the electrode and the Digivac. For best results, the tubing should be metal.
- In extreme cases, the gauge can be absolutely protected by installing a normally open solenoid valve between the gauge tube and the system. The solenoid valve coil should be in parallel with the bombarding transformer. In this way, the solenoid will be closed and the gauge tube will be positively protected whenever bombarding is done.
- If a gauge is damaged by bombarding, it can generally be brought back to operating condition by replacing the Op amp which controls the gauge tube current. Consult Digivac.

The set point connections are in the back of the unit. There are 2 rows of pins. The top row of pins is for set point 1, and the bottom row of pins is for set point 2. The top 3 pins are in the order:

1. **Common** – The common line of a switch



2. **N.C.** – Normally closed. This means that above the set point value there is a current path between the common and the N.C. terminal. Put another way the switch is "ON" between these 2 terminals. At the set point value and below (higher vacuum, lower pressure) the connection is open. Put another way, the switch is "OFF" between the common and the N.C. connection at higher vacuum (a lower vacuum reading).
3. **N.O.** – Normally open. This means that above the set point value there is no current path between the common and N.O. connection. Put another way the switch is "OFF" between these 2 terminals. When the vacuum indication goes below the set point value (higher vacuum, lower pressure) the current path closes. Put another way the switch is "ON" between the N.C. and N.O. connections at absolute vacuum readings below the set point value.

Take care in insuring that the wire connections are made fast, and the voltage and current does not exceed 250V or 7A. If you need to control a device that draws more power, consider another relay in between the Digivac output and the device to be controlled

Note that for units ordered with the VLC option, the port for Set Point 1 is used for the high speed valve connection. The set point to control vacuum level would be set by using the buttons on the front of the unit for Set Point 1.

The Analog output is located in the center of the back panel, and should be connected to a high impedance input. The output impedance is 1KΩ.

The RS232 connection can be made to a PLC or computer via a male DB9 cable connection to the female DB9 connection on the Digivac. The Digivac acts as a DCE, so a straight serial connection is appropriate.

Please use the supplied 5V AC adapter with your Instrument. This adapter provides clean short protected power to protect and insure accuracy of the internal circuitry.

5.0 OPERATION

After installation, the DIGIVAC is ready for immediate operation. The unit will normally provide accurate readings immediately however, occasionally a gauge tube will have absorbed material during storage, and may require as much as 24 hours of operation before accurate readings are attained. It is recommended that the DIGIVAC be energized continuously during vacuum system operation. In this way, the hot filament will not allow contaminants to condense.

In cases where the system has contaminants, as is often the case with metalizing and coating equipment, it is often effective to isolate the gauge tube with a solenoid or manual valve during periods when contamination is most active.

The Digivac controller can be easily set to the desired units on the fly:

1. Press the “sel” key three times during normal operation. The currently selected units will blink
2. Press the “⮝” and “⮟” to get to the desired unit.

3. Press “Ent” to complete your selection.

The Digivac 215 has 2 set points that can be used to actuate external equipment. These 2 set points can be adjusted from the front of the gauge in your currently selected units.

1. To change SP1:
   a. Press the “sel” key once to enter in set point 1. The SP1 LED should now blink
   b. Press the “⋀” and “⋁” to get to the desired set point value. Note the set point units are in milliTorr. For example a set point of 1000 is equal to one Torr.
   c. Press enter to accept the new set point value. Normal run mode will resume.
2. To change SP2:
   a. Press the “sel” key twice to enter in set point 2. The SP1 LED should now blink
   b. Press the “⋀” and “⋁” to get to the desired set point value
   c. Press enter to accept the new set point value. Normal run mode will resume.
3. If you don’t want the set points to actuate or the LEDs to illuminate at all, set the set point for “000”.

One of the units LEDs to the right of the LCD will always be lit during normal operation to indicate which pressure range the display is indicating.

The Instrument has additional outputs which can be used:

- **RS232** – The instrument puts out a standard RS232 serial stream with settings 9600, 8, N, and 1. The unit transmits but does not receive, and displays the current vacuum indication in the current units.
- **Analog out** – This output reads from 0 to 5 Volts from a pressure of 1 micron all the way up to 5 Torr. There is a graduation of 1 milliVolt per milliTorr. Therefore, 10 milliVolts = 10 milliTorr, and 4 Volts = 4 Torr.

215 VLC Tuning instructions

The 215 can operate as a vacuum level controller when so configured. The solenoid valve is mounted as close to the vessel as appropriate, with the wires for the solenoid valve terminating on pins 1 & 2 of the “SP1” connector. Set the VLC setpoint by setting setpoint 1 as above to the desired vacuum level to be maintained. The 215 has been tested on vessels from 0.5 gallons to 25 gallons with good success. In many cases, you may not need to touch the PID tuning variables. In the event that the control out of the box doesn’t work well, you can change the P, I and D variables to obtain a more desirable result.

To get to the PID tuning variables, press the “SEL” button until you get to a screen that says “tune”, then hit “ENT”

- Hit “Sel” to the desired variable, either “P”, “I”, or “D”
- When the desired variable is displayed, Press the “⋀” and “⋁” to get to the desired value
- Press “ENT” when completed. Not pressing enter will result in no change of PID value.

PID Overview:

PID control is largely used in industry, and refers to the variables in the control equation "proportional," "integral," and "derivative."

- P is implemented as a proportional gain (not as a proportional band). Larger values of P yield smaller error with less stability. The range is 0.000 to 9.999 with units of %.
- I is also a gain. Larger values of I will yield faster response with less stability. The range is 0.00 to 20.00 with units resets/minute
- The D Range is 0.000 to 9.999 with units of minutes.

Here are the recommended PID tuning steps:

- Start with P=0.002 and I = .5
- Slowly increase P until oscillations are observed.
- Decrease P by about 30%
- Slowly increase I while disturbing the process (let in air or change setpoint) until desired response (overdamped/underdamped) is achieved.
- D hasn't been required in our testing.

Below are some PID examples for the 215 VLC:

Gauge type	Code Version	Vessel size	Pump	CFM	LPM	Set Point	P	I	D	Overshoot	+/- Band
201VLC	Model_201_pcbchangeTorr.c	1.5 Gallon	Welch 1405	3.2	60	0.100	0.002	0.500	0.000		
201VLC	Model_201_pcbchangeTorr.c	.5gallon	Welch 1405	3.2	60	0.100	0.002	0.500	0.000		0.0010
201VLC	Model_201_pcbchangeTorr.c	.5gallon	Welch 1405	3.2	60	0.310	0.002	0.500	0.000		
201VLC	Model_201_pcbchangeTorr.c	.5gallon	Welch 1405	3.2	60	0.500	0.002	0.500	0.000	0.600	
201VLC	Model_201_pcbchangeTorr.c	.5gallon	Welch 1405	3.2	60	0.800	0.002	0.500	0.000	0.930	
201VLC	Model_201_pcbchangeTorr.c	.5gallon	Welch 1405	3.2	60	1.200	0.002	0.500	0.000	1.378	
201VLC	Model_201_pcbchangeTorr.c	.5gallon	Welch 1405	3.2	60	1.500	0.002	0.500	0.000	overshoot	
201VLC	Model_201_pcbchangeTorr.c	.5gallon	Welch 1405	3.2	60	7.600	0.002	0.500	0.000	9.000	0.0400
201VLC	Model_201_pcbchangeTorr.c	.5gallon	Welch 1405	3.2	60	12.400	0.002	0.500	0.000	16.800	0.0400
201VLC	Model_201_pcbchangeTorr.c	.5gallon	Welch 1405	3.2	60	20.000	0.002	0.500	0.000	21.000	0.5000
201VLC	Model_201_pcbchangeTorr.c	.5gallon	Welch 1405	3.2	60	20.000	0.002	0.200	0.000		
201VLC	Model_201_pcbchangeTorr.c	.5gallon	Welch 1405	3.2	60	20.000	0.111	0.200	0.000		1.5000
201VLC	Model_201_pcbchangeTorr.c	.5gallon	Welch 1405	3.2	60	20.000	0.100	0.200	0.000		1.5000
201VLC	Model_201_pcbchangeTorr.c	.5gallon	Welch 1405	3.2	60	20.000	0.100	0.350	0.000		
201VLC	Model_201_pcbchangeTorr.c	.5gallon	Welch 1405	3.2	60	20.000	0.100	0.650	0.000		
201VLC	Model_201_pcbchangeTorr.c	.5gallon	Welch 1405	3.2	60	20.000	0.100	5.000	0.000		1.5000
201VLC	Model_201_pcbchangeTorr.c	.5gallon	Welch 1405	3.2	60	20.000	0.100	1.900	0.000		
201VLC	Model_201_pcbchangeTorr.c	.5gallon	Welch 1405	3.2	60	0.550	0.004	0.200	0.000		
201VLC	Model_201_pcbchangeTorr.c	11.2 Gallon	Leybold Trivac D	1.59	45	0.200	0.020	0.100	0.000	0.204	0.0001
201VLC	Model_201_pcbchangeTorr.c	11.2 Gallon	Leybold Trivac D	1.59	45	0.510	0.020	0.100	0.000	0.518	0.0002
201VLC	Model_201_pcbchangeTorr.c	11.2 Gallon	Leybold Trivac D	1.59	45	0.910	0.020	0.100	0.000	0.912	0.0010
201VLC	Model_201_pcbchangeTorr.c	11.2 Gallon	Leybold Trivac D	1.59	45	5.000	0.020	0.100	0.000	0.912	0.0060
201VLC	Model_201_pcbchangeTorr.c	11.2 Gallon	Leybold Trivac D	1.59	45	10.100	0.020	0.100	0.000	10.680	0.0300
201VLC	Model_201_pcbchangeTorr.c	11.2 Gallon	Leybold Trivac D	1.59	45	20.000	0.020	0.100	0.000	22.000	0.0200

6.0 SERVICING

GAUGE TUBE SERVICING

In many cases, a gauge tube may become fouled with oil or other foreign matter. It is often possible to restore the functionality of contaminated probes with cleaning. If the contaminant is known, the tube should be filled with a fluid that is known to be a solvent to that contaminant. As an example, ether is often effective in removing residues of some oils. Commercial carburetor cleaners are very powerful solvents and are highly effective against some contaminants.

After cleaning with solvents, the gauge tube should be completely dried or flushed with a volatile solvent to assure that it is dry prior to re-installing it. If this is not done, contamination of the system may result.

6.1 FACTORY REPAIR AND CALIBRATION

The vacuum gauge assembly is designed to provide years of trouble-free service, and the liberal internal use of plug-in components make it easily repairable. No field servicing of the unit is recommended, other than replacement of the gauge tube, but factory servicing and calibration are available at a nominal cost and turn-around times of 24 hours are typical.

6.2 FIELD CALIBRATION

Each Digivac vacuum gauge controller is calibrated to the particular vacuum gauge sensor that is shipped with the unit. While changing the gauge tube is possible, it will result in a slightly different reading as all gauge tubes are not created equal. Although it is preferable that all calibration be performed at Digivac, field calibration can be accomplished.

Before re-calibrating the instrument, it should be ascertained that the instrument is in fact incorrect. In many cases, the problem will be with a tube that is fouled, or a system that is operating improperly. It is recommended that a spare tube be kept on hand and stored in a clean, dry place. Then, in cases of suspect readings, the tube should be changed before proceeding further.

If adjustments are to be made, proceed as follows:

A) Remove the Instrument from the panel.

B) Remove the front panel cover of the instrument and locate the two calibration potentiometers. The “Zero” potentiometer is to the right as you look at the LED Display, the “ATM” or span adjust is to the left closest to the outside of the board.

C) Precalibrate

   a. Set the device on a table top with the tube plugged in

   b. Place a voltmeter lead on ground (center pin below display)

   c. Place the positive voltmeter lead on the lower side of the beige capacitor on the top of the board to the left of the display

   d. Adjust the Zero POT to read 1.77 Volts

   e. Place the Positive voltmeter lead in the via that is located on the left side of the board towards the edge

   f. Adjust the span pot so the voltage is 1.185 Volts

D) Operate the vacuum system at the lowest attainable pressure, and allow the system and the gauge tube to stabilize for several minutes. Factory zero setting is done at a pressure of .1 milliTorr (.1 micron) or less.

E) Adjust the zero setting potentiometer so the unit reads zero. Make sure not to under span. Allow the measurement standard to rise to 1 milliTorr and make sure the gauge reading also reads 1 milliTorr. (Note the POTS are counter intuitive, clockwise makes the value go down and vice versa, and are very sensitive..)

F) Check the operation of the gauge at other pressures. Normally, adjustment of the zero will not be interactive with the readings of the instrument at higher pressures.

G) The ATM adjustment is normally not necessary. If necessary, adjust the span with the ATM potentiometer.

   a. For the 215H set the vacuum level to a steady 1980 milliTorr, and slowly turn the potentiometer on the right until the Digivac gauge reads 1980 milliTorr

   b. For the 215V, set the vacuum level to Atmosphere (approximately 760 Torr) and slowly turn the potentiometer on the right until the Digivac gauge reads 760 Torr, being careful not to over span.

   c. If you adjust the span, recheck the zero, then the span, and the zero one last time.

7.0 NOTES ON CALIBRATION

The DIGIVAC is calibrated in nitrogen, which has thermal properties virtually identical to air. Other gasses will affect the readings by an amount proportional to the thermal conductivity of the gases. In most cases, the gases present in a vacuum system will be air, nitrogen, or oxygen, and no appreciable errors will occur.

Certain other gases, however, have thermal conductivity significantly greater than air and will cause the instrument to read higher than the actual amount of pressure. Examples of such gasses are water vapor, fluorocarbon refrigerants, and acetone. Conversely, other gasses have thermal conductivity significantly lower than air and will cause the instrument to read lower than actual pressure. Examples of such gasses include helium, oxygen and to a lesser extent, CO2.

When interpreting readings using gasses other than air, it should be borne in mind that the DIGIVAC reads Torr, which is a measure of absolute pressure - that is the opposite of vacuum. Thus, a lower numerical reading actually is a higher level of vacuum. For more information, refer to section 8.0.

When in doubt, consult Digivac.

8.0 UNDERSTANDING TORR

The DIGIVAC and many similar instruments are calibrated in microns or "milliTorr." It is appropriate to discuss what microns are and to relate microns to other measures of pressure and vacuum. Microns are not really a measure of vacuum at all, but rather of absolute pressure. It will be recalled that the pressure of the atmosphere is 14.696 or approximately 14.7 pounds per square inch at sea level. This pressure is due to the weight of all of the air in the earth's atmosphere above any particular square inch. This 14.696 psi is equivalent to the pressure produced by a mercury column of approximately 29.92 inches high or .76 meters (about 3/4 of a yard) or 760 millimeters of mercury. Atmospheric pressure varies greatly with altitude. It decreases approximately 1 inch of mercury per thousand feet of altitude. It also varies widely with local weather conditions. (Variations of one half inch in a single day are common.) The word vacuum means pressure lower than atmospheric or "suction," but, in describing negative pressure, the atmosphere is only a satisfactory reference if we are dealing with values of vacuum down to about 27 inches of mercury. Below that, it is much more useful to talk in terms of absolute pressure, starting from absolute zero. The DIGIVAC and all similar instruments do just this.

One TORR, a commonly used unit, is an absolute pressure of one millimeter of mercury. A milliTorr is equal to one thousandth of a TORR. A MICRON is the same as a milliTorr. The full scale reading of a DIGIVAC is 1999 microns and is equivalent to 1.999 TORR of approximately 2/760 of atmospheric pressure. This is less than .1 inches of mercury, and less than .05 PSI.

9.0 ACCESSORIES AND MODIFICATIONS

The following are offered as accessory equipment or field-installed modifications.

Padded shoulder strap Case with Velcro closure- For instruments that will be used in the field, particularly in cryogenic applications, a padded shoulder strap case is available. This case holds a Digivac 100tc battery powered gauge in the optimal reading position. The operator can open the Velcro cover, pull out the gauge tube cable, plug it into the tube on the equipment, and see the reading. It was developed to assist in field service of cryogenic tank farms and vacuum jacketed piping.

COMPATIBILITY WITH OTHER GAUGE TUBES

On special order, Digivac Instruments can be provided to use with most other vacuum gauge tubes. AC and DC excitation are available. Gauges have been provided for Hastings, Varian, Thermionics, Veeco, VRC, and Fredericks gauge tubes.

SPECIAL REQUIREMENTS

It is the policy of the Digivac Company to customize instruments for specialized requirements whenever it is economically feasible to do so. We encourage inquiries about your special needs.

For repair or recalibration, return gauges to:

The DigiVac Company
105B Church Street
Matawan, NJ 07747

Ph: 732.765.0900
Fax: 732.765.1800

E-mail: Direct from our website **www.digivac.com**

The Digivac Company manufactures a complete line of vacuum gauges and computers. Contact us or your distributor if you wish for further information.

See www.digivac.com for our latest offerings